May 2002

Advisory Circular (Working Draft – Not For Public Release)
AC No: 25-795(d)

Subject: Survivability of Systems

1. Purpose: This Advisory Circular provides a means, but not the only means, of compliance with § 25.795(d) , and discusses the rulemaking which implements ICAO Annex 8, Appendix 97 Standards, pertaining to an aircraft design requirement for Survivability of Systems for all new (passenger) aircraft with greater than 60 seats or a 100,000 Pounds MTOW.

2. Related FAR Sections: Title 14, Code of Federal Regulations (14 CFR) Parts 25 and 14 CFR §§ 25.365; 25.795; 25.1309

3. Discussion: The International Civil Aviation Organization adopted certain requirements related to security aspects of airplane design in amendment 97 to Annex 8. Included is a requirement that flight-critical systems should be designed and separated such that airplane survival is maximized for any event (e.g., damage due to an explosive device) that causes airplane system damage. For the purpose of addressing this requirement, any structural damage that might result from these events is not considered. This requirement only addresses damage to systems and their effect on safe flight and landing. Flight-critical systems shall be specified by the manufacturer. Section 25.795(d) does not introduce reliability requirements for systems and does not mandate redundancy for systems that are not required to be redundant.

4. Compliance: There are at least two approaches that will satisfy the systems survivability requirement. These are achieved through systems separation or systems protection. Systems separation is based on the idea that any critical system having a redundant or backup system can be separated sufficiently to ensure a high probability that both systems will not be damaged from any single event. Systems protection is attained by shielding critical systems against any harmful event. Designing for systems protection, instead of separation, should only be relied upon if separation is impractical.

   Although airplane fuselage diameters vary widely, the percentage of space devoted to systems installations in general decreases with larger airplanes. This is partly because the size of systems are driven more by their function than by the size of the airplane. That is, space allocation for individual systems does not vary significantly with airplane size. This affords the opportunity of larger airplanes to separate systems to a greater extent than smaller ones. Even if systems were scaled with airplane size, the allowable separation distances would naturally increase with airplane size. The separation requirement provided below recognizes this physical relationship.

In order to provide a reasonable and practical method for establishing a minimum separation between redundant systems, the following formula, derived from § 25.365(e), is defined in the rule:

$$D = 2\sqrt{(PA_S / \pi)}$$

Where:

D = minimum separation distance between redundant systems, in feet.

$$P = \frac{A_S}{6240} + 0.024$$

A_s = maximum cross-sectional area of pressurized shell normal to the longitudinal axis, in square feet

The separation distance, D, need not exceed 5.05 feet. This formula would be used anywhere within the pressurized fuselage. The requirement to maintain systems separation distances, based on this formula, is not intended to be applied to areas outside of the fuselage inner mold line (IML) e.g., wing root or empennage.

Certain areas within the fuselage may be excluded from strict application of the separation criteria but are nevertheless expected to achieve the best separation distances possible. Specific areas that meet this limited exclusion include:

a. Fuel tanks - not considered to be a system that can be separated.
b. Flight deck - aircraft geometry and convergence of systems in this area precludes full system separation.
c. Areas where physical separation is impractical due to airplane geometry or other constraints (e.g., the aft fuselage area where the fuselage diameter tapers, preventing full separation).
d. Electronic & Equipment Bays - concentration of numerous systems in a confined area prevents full separation. These areas should receive special consideration since they contain a large number of flight-critical systems. In this case, redundant systems should be separated within the compartment to maximize the potential for continued function after an event. This could be achieved, for example, by locating flight-critical systems in areas of the E&E bay furthest from the passenger or cargo compartments. Blast shielding is not a substitute for system separation but may be a useful approach for the E&E bay.

Figure 1 illustrates the regions that critical systems must be separated. Except for the items specifically excluded, if redundant systems separation is unattainable in a specific area, then one of the redundant systems and its vital components must be protected in that area. Protection should only be pursued if separation is not an available option. Acceptable systems shielding and/or inherent protection should be able to withstand fragment impacts from 0.5-inch diameter 2024-T3 aluminum spheres traveling 430 feet per second without disabling the system. The ballistic resistance of 0.09-inch thick 2024-T3 aluminum plate offers an equivalent level of protection. Credit may be taken for any permanent barriers between the system and a potential explosive device location that can be shown to offer fragment protection. In addition, the system design must incorporate features that minimize the risk of its failure due to large displacement of the structure to which it is attached. This may include flexibility in both the system and/or its mountings. In the absence of test evidence, alleviating rationale or special circumstances, provisions should allow for a minimum 6-inch displacement in any direction from a single point force applied anywhere within the protected region. Frangible attachments or other features that would preclude system failure may also be incorporated.

The use of shielding should only be provided to protect the systems against ballistic threats and not against blast pressures. Several explosive tests conducted by the FAA have shown that systems are unaffected by blast pressures and efforts to defend the system against blast will likely increase damage rather than mitigate it. Therefore, ballistic shielding should be no larger than absolutely necessary to allow the blast pressures to pass without resistance.

Compliance shall be shown by design and analysis for each affected zone and flight-critical system.

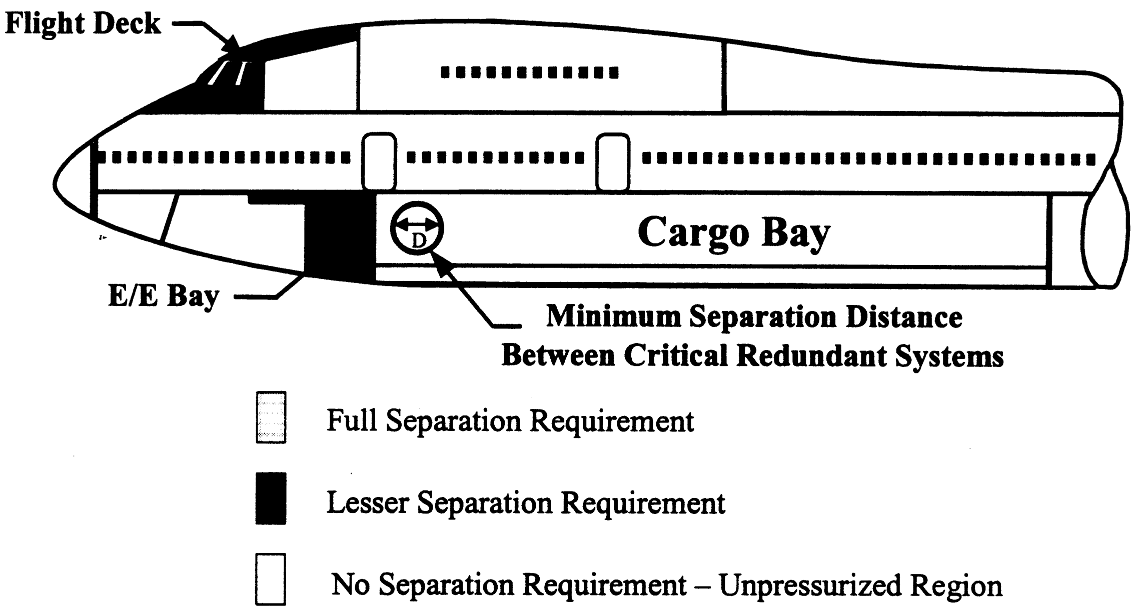

Figure 1. Regions Requiring Separation of Critical Redundant Systems